Endemic sheep and cattle diseases & greenhouse gas emissions in Scotland

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Introduction

Livestock play an important role in the generation of stability and wealth of many communities around the developing and developed world. In 2014, there were approximately 1.5 billion cattle, and 1.2 billion sheep worldwide (Food and Agriculture Organization of The United Nations, 2016). Livestock are used not only as a protein source but also to provide a workforce, raw materials and a source of income (both directly and indirectly). A further important factor to consider in relation to livestock (particularly sheep and goats) in an EU context is that they are ideally suited for land designated as a Less Favoured Area (LFA) i.e. an “area with natural handicaps (lack of water, climate, short crop season and tendencies of depopulation), or that is mountainous or hilly, as defined by its altitude and slope” (OECD 2016). The grazing of LFA is extremely important for countries like Scotland where around 80% of its agricultural land is designated as such.

The red meat sector is a key contributor to many rural and national economies including the UK, however, ruminant production also contributes significantly to the carbon footprint of livestock farming. Emissions of enteric and manure methane from sheep and cattle accounted for just over half (52%) of Scotland’s total agricultural greenhouse gas (GHG) emissions in 2013 (Salisbury et al., 2015). Reducing the emissions intensity (i.e. the amount of GHG emitted per unit of meat or milk produced) of ruminants is, therefore, key to reducing agricultural emissions in Scotland.

Considering the benefits derived from livestock and the damage from GHG emissions, it is imperative that livestock production is as efficient, sustainable and profitable as possible. Endemic, production-limiting diseases are a significant constraint on efficient and sustainable livestock production in Scotland and around the world. Dealing effectively with endemic livestock diseases represents an opportunity to reduce emissions from the livestock sector, often without compromising productivity or farm economics. This paper outlines the findings of a rapid evidence assessment, commissioned by the Scottish Government (Skuce et al. 2016), which investigates the potential contribution that improving cattle and sheep health could make to reducing GHG emissions in Scotland. The specific aims of the assessment were to a) Review the evidence on 12 of the main diseases affecting Scottish dairy cattle, beef cattle and sheep, and provide a qualitative assessment of the cost-effectiveness and feasibility of control options and their likely impact on production and GHG emissions b) Perform example calculations of the effect of control options on production, total GHG emissions and emissions intensity and use these to illustrate the utility, and limitations, of the approach. c) Highlight the policy challenges faced when seeking to mitigate GHG emissions via improved livestock health.
Approach

Scoping livestock diseases and their potential effects: Policy makers and the authors agreed a list of major diseases of cattle and sheep in Scotland, where ‘Major’ is defined as those diseases that are (i) most economically costly, and/or (ii) the most wasteful in GHG emissions intensity (EI; where it is known or can be inferred). The diseases considered, including some zoonotics, were fasciolosis, footrot, infectious bovine rhinotracheitis (IBR), Jaagsiekte, Johnes, leptospirosis, neosporosis, ovine enzootic abortion (EAE), parasitic bronchitis, parasitic gastroenteritis (PGE), sheep scab and toxoplasmosis. Opinion and specific disease information was then sought from acknowledged experts (where available), on areas such as health and welfare implications, prevalence, production effects, climate change impact/implications, mitigation and adaptation options, disease control options and likely costs. We assessed the available evidence for the control or eradication of the major diseases in terms of (i) abatement potential, and (ii) cost-effectiveness (in both financial terms, and in units of carbon dioxide equivalents (CO2e) saved compared with business as usual). This allowed for qualitative assessment of abatement potential, based on both impact and feasibility of control or eradication (aim a). For example, Johne’s disease has a major impact on EI, but the abatement potential is limited. Conversely, IBR has moderate impact on EI but tools for its eradication exist and have been implemented successfully in numerous countries. From this three possible candidates for further analysis were selected.

Quantifying the effects of disease control on emissions intensity: Quantitative analysis of the effects of disease reductions in disease prevalence and impact were undertaken for two of the case studies. A Microsoft Excel version of GLEAM (the Global Livestock Environmental Assessment Model, see: http://www.fao.org/gleam/en/) was used to compare emissions and production between a healthy herd/flock and one with infection or disease. This approach enabled a variety of parameters to be varied in order to capture the effects of infection, such as growth rates, mortality rates, and fertility.

Findings

Potential GHG emissions savings were identified for all twelve diseases evaluated, but some diseases proved more tractable than others in terms of the availability of practical diagnostic and control options. Some diseases will have more GHG abatement potential than others based on their prevalence, impact on infected animals etc. Examples of diseases that are difficult to control include Johne’s disease and fasciolosis (liver fluke), both of which have diagnostic tests with severe limitations and environmental reservoirs. Based on the qualitative comparisons, we identified a ‘Top 3’ of diseases, one each from the major livestock sectors, to consider for potential eradication and/or government policy intervention. These were neosporosis (beef cattle; major cause of abortion), infectious bovine rhinotracheitis, IBR (dairy cattle; significant impact on milk production; eradication feasible) and parasitic gastroenteritis (PGE, sheep; impact on growth and FCR), respectively. Based on the quantitative comparisons, abatement was possible, and likely to be economically viable and practically feasible for IBR and PGE. Although neosporosis is the major cause of abortion in beef cattle and therefore expected to impact significantly on EI, insufficient data were available to substantiate abatement potential and feasibility of its control. This is due, in part, to the fact that the
impact of neosporosis is largely linked to abortion storms, which are difficult to capture with prevalence data from herd surveys.

Discussion

Overall, the evidence suggests that reductions in GHG emissions intensity (EI) could be achieved through the implementation of cost-effective control measures that impact on the parameters EI is particularly sensitive to, i.e. (i) milk yield and cow fertility rates (dairy systems), (ii) cow/ewe fertility and abortion rates, calf/lamb mortality and growth rates (beef and sheep systems), and (iii) feed conversion ratios, FCR (all systems).

There are a number of important limitations and assumptions implicit in the disease-specific inputs into the GHG model calculations. For most endemic diseases, there is a complete lack of active surveillance, with limited passive surveillance and inconsistent reporting. Without knowing the prevalence and incidence of individual diseases, the likely impact of control on GHG emissions cannot be predicted accurately. Furthermore, where data on prevalence or incidence are available from peer-reviewed or grey literature, they do not always reflect recent changes in disease epidemiology and occurrence. Where possible, data were used from Scotland, the UK, the British Isles, or Europe (in that order), rather than from other countries, but in many cases, we were reliant on estimates of prevalence, incidence and production impacts derived from other nations and countries, where climatic conditions, land use, and farm management practices may be considerably different from those in Scotland. Even within the UK, major differences exist, e.g. between dairy and beef farming, between lowland and hill sheep farming conditions and between different geographic regions. As a result, quantifying the abatement potential and cost-effectiveness of health improvement measures presents a variety of challenges. Performing the analysis using (national) averages can furthermore obscure cost-effective measures. Also, some potentially important disease impacts are poorly understood. For example, feed conversion rates, which are a key determinant of EI, are not routinely measured for ruminants.

Another consideration is the interaction between multiple pathogens e.g. gastrointestinal nematodes and Johne’s or liver fluke and bovine TB (Claridge et al., 2012), and the implications of controlling one disease on the potential outcome and impact of another. We have focused our report on those diseases that are, at least clinically, attributable to a single pathogen (virus, bacterium, parasite) or multiple, closely-related pathogens, as in the case of PGE, where the causative agents are known and their epidemiology reasonably well understood. In real life, production is affected by many parameters, including breed, nutrition, co-infections, etc. Hence, estimated production impacts may not always be exclusively attributable to the organism or disease of interest. One of the challenges of estimating the abatement potential of multiple diseases is in understanding the net effect of implementing multiple measures for different diseases. The improvements in performance will not always be additive, which raises the possibility of double counting of abatement. Double accounting may also occur within the calculations for individual diseases, e.g. when early embryonic death due to Neospora infection is included as a reduction in fertility as well as an extension of the
average calving interval. Interactions between measures are a common challenge in GHG mitigation analysis (see MacLeod et al. 2015). In order to address this, ADAS (2014) assessed the total abatement from improving cattle health using a scenario-based approach to quantify the effects of a 20% and 50% movement from a reference to a healthy cattle population.

Sustainable control of endemic, production-limiting disease represents a potential win-win situation, i.e. it could provide both private benefits (e.g. increased farm profits) and social benefits (e.g. reduced GHG emissions and improved animal welfare). However, a number of caveats apply; if GHG mitigation options are to be widely taken up by livestock farmers, as they must be to ensure sufficient impact, then they must be relatively straightforward, practical and cost-effective to implement.

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